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Alaska Helicopter Tours Sound Measurements: Juneau, Alaska

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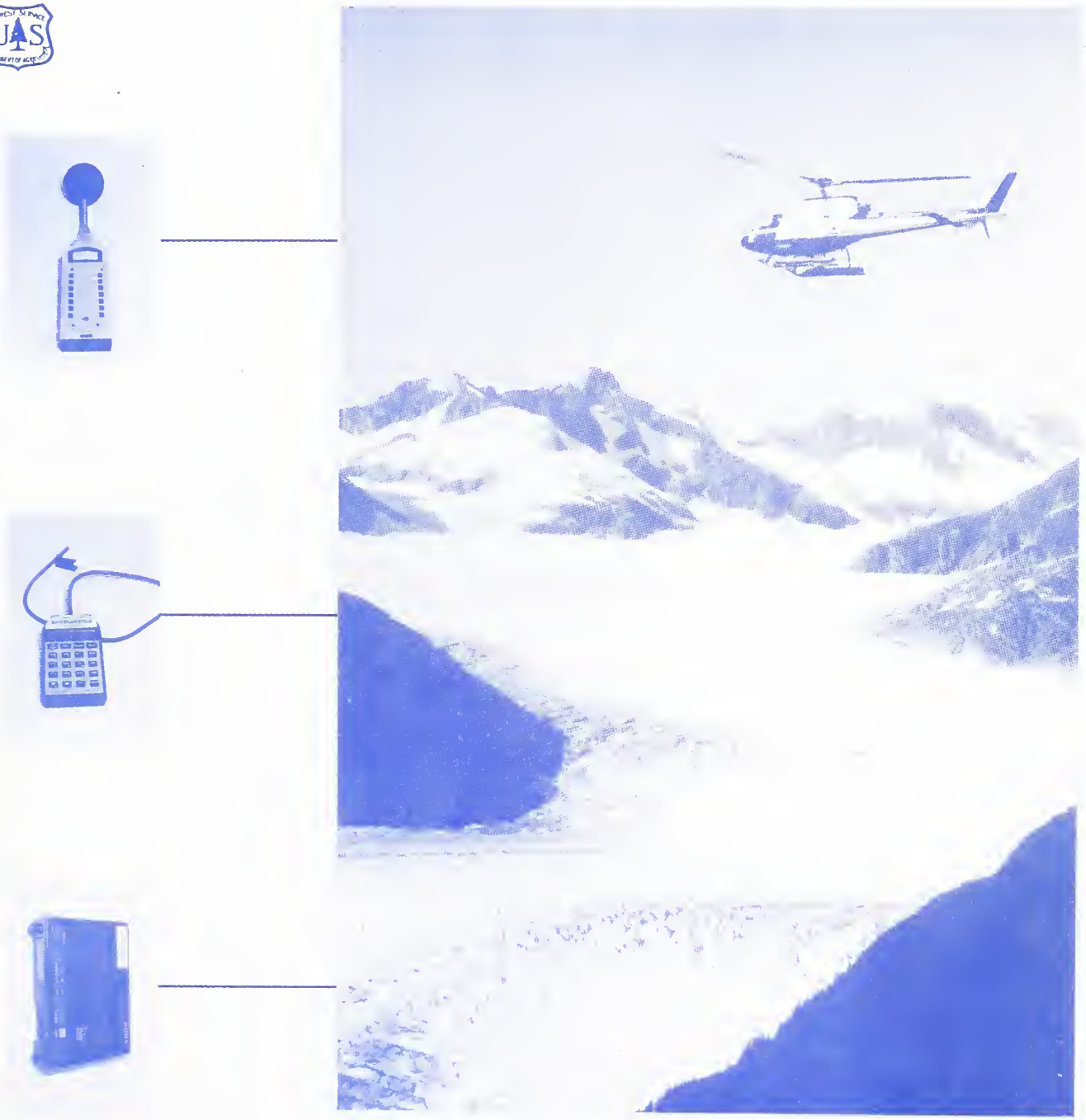


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Alaska Helicopter Tours Sound Measurements Juneau, Alaska June 1993

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Noise Control in Forest Recreation

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INTRODUCTION

Measurements of helicopter sound and the ambient background sound were made at twelve locations throughout the Juneau, Alaska area to aid in the assessment of the sound impact of helicopter landing tours. These measurements were captured on tape and analyzed in the laboratory to allow comparisons of the overall environmental sound levels with and without the helicopter sound present. The main focus of these measurements was on the helicopter sound impact to the local residents.

Community noise is a complex and often emotional issue with many physical and psychological variables. However, most authorities agree that, with respect to hearing health and annoyance (at least to a first approximation), the human response to sound is proportional to the total sound energy received. This is to say, for example, when exposed to a given sound level for one hour, the same number of people will be moved to complain when subjected to that sound level, minus 3 dB (half the energy), for two hours. Because of this phenomenon, equivalent energy metrics, such as equivalent level (Leq) and day-night average level (Ldn), are commonly used in studies to predict community response to noise. (Reference 1.)

Equivalent level (Leq) is a single descriptor that represents the continuous sound level that would have the same acoustic energy as a fluctuating sound level, when measured over the same time period.

The Day-Night Average Sound Level (Ldn) is the currently accepted metric used to assess aircraft sound exposure. Ldn is defined as "the 24-hour average sound level, in decibels, for the period from midnight to midnight, obtained after the addition of 10 decibels to sound levels for the periods between midnight and 7 a.m., and between 10 p.m. and midnight, local time." (Reference 2.)

The Ldn method is used to assess the accumulated effect of all aircraft sound and does not allow for discrimination between aircraft types. Since the objective of these tests was to assess the sound impact of only the helicopter landing tour activities with regard to annoyance, a more selective method was necessary.

The method used in this study compares the equivalent sound level (Leq) of the background or ambient sound (the level that would exist if the helicopters were not present) to the combined Leq (the level including the contribution of the sound from the helicopter landing tour operations). This allows the helicopter landing tour activities' contribution to the total sound level for that time period to be quantified for comparison purposes.

To accomplish this, the Juneau Ranger District selected 12 measurement sites around the Juneau area. Cruise ship schedules were consulted to anticipate the level of helicopter landing tour activity. An attempt was made to take measurements during extensive helicopter activities in the areas of interest. This results in a much more sensitive and severe methodology than the Ldn method because of the way the data was sampled (short time periods with a high level of helicopter activity).

Calibrated recordings of the sound levels at each site were made using precision sound level meters and a Digital Audio Tape (DAT) recorder. Logs were kept to identify significant sound events during the recordings. These recordings were then analyzed in a laboratory, where the overall combined sound levels (both the background and the helicopters) were measured, and the sound levels from the helicopter activities were then subtracted. The result of this subtraction is the background or ambient sound level which would exist if the helicopter activities were not present. By comparing the two levels, the relative impact of the sound from the helicopter activities can be quantified.

INSTRUMENTATION

The measurements were made with two B&K Sound Level Meters (Type 2231) and recorded with a Sony two-channel Digital Audio Tape (DAT) recorder. Measurements were also made with two B&K Noise Dose Meters (Type 4436) for backup, which use an internal computer chip to store the data before it is dumped to a personal computer (PC).

All instruments were calibrated daily with a B&K Sound Level Calibrator (Type 4230) and calibration signals were recorded on the data tapes at the beginning and end of each test segment. In addition, all instruments had been laboratory calibrated before the tests.

The data tapes were analyzed at the laboratories of the San Dimas Technology and Development Center and BBN Systems and Technologies. A B&K Type 2131 Digital Spectrum Analyzer, a B&K 2231 Sound Level Meter, and LabWare, BBN's Laboratory Data Acquisition Software were used for the analysis.

SUMMARY OF TEST RESULTS

The results of the sound measurements are shown in the following table:

Table 1.—*Sound measurement test results.*

Site#	Combined Leq (dBA)	Background Leq (dBA)	Change Leq (dBA)
1	56.4	51.8	4.6
2	57.9	57.4	0.5
3	47.7	39.3	8.4
4	55.3	53.5	1.8
5	54.9	54.3	0.6
6	61.7	61.3	0.4
7	50.3	47.3	3.0
8	55.4	54.0	1.4
9	54.0	52.5	1.5
10	54.5	49.4	5.1
11	46.4	37.2	9.2
12	------ Too Much Wind Noise-----		

DISCUSSION OF RESULTS

The graph in figure 1 shows a relationship between noise exposure and level of community annoyance. (Reference 1.) This relationship is used as a general guideline for this analysis to assess the acoustic impact of the helicopter operations in question. The difference between the annoyance percentage for the background and combined sound levels indicates the relative impact for each site. It must be strongly emphasized that the annoyance percentages shown on the graph are guidelines only, based on an empirical dosage-effect relationship using Ldn. The reader is cautioned to avoid the common temptation to "grasp at numbers."

MEASUREMENT SITES

Site #1

Site #1 is located near the center of an approximately 1/2 square mile residential area located about 1/4 mile northwest of Juneau Airport, near the Mendenhall Wetlands State Game Refuge. (See figure 2.) The residential area is surrounded on three sides by industrial and commercial zoned areas.

A 50-minute test segment, recorded on June 17, 1993, was analyzed. It contained 10 events in which helicopters could be heard. The combined Leq (including both the background and helicopter sounds) for the 50-minute segment was 56.4 dBA. The helicopters were audible for approximately 9 minutes of the 50-minute test segment, or about 18 percent of the time. After removing the helicopter sounds to

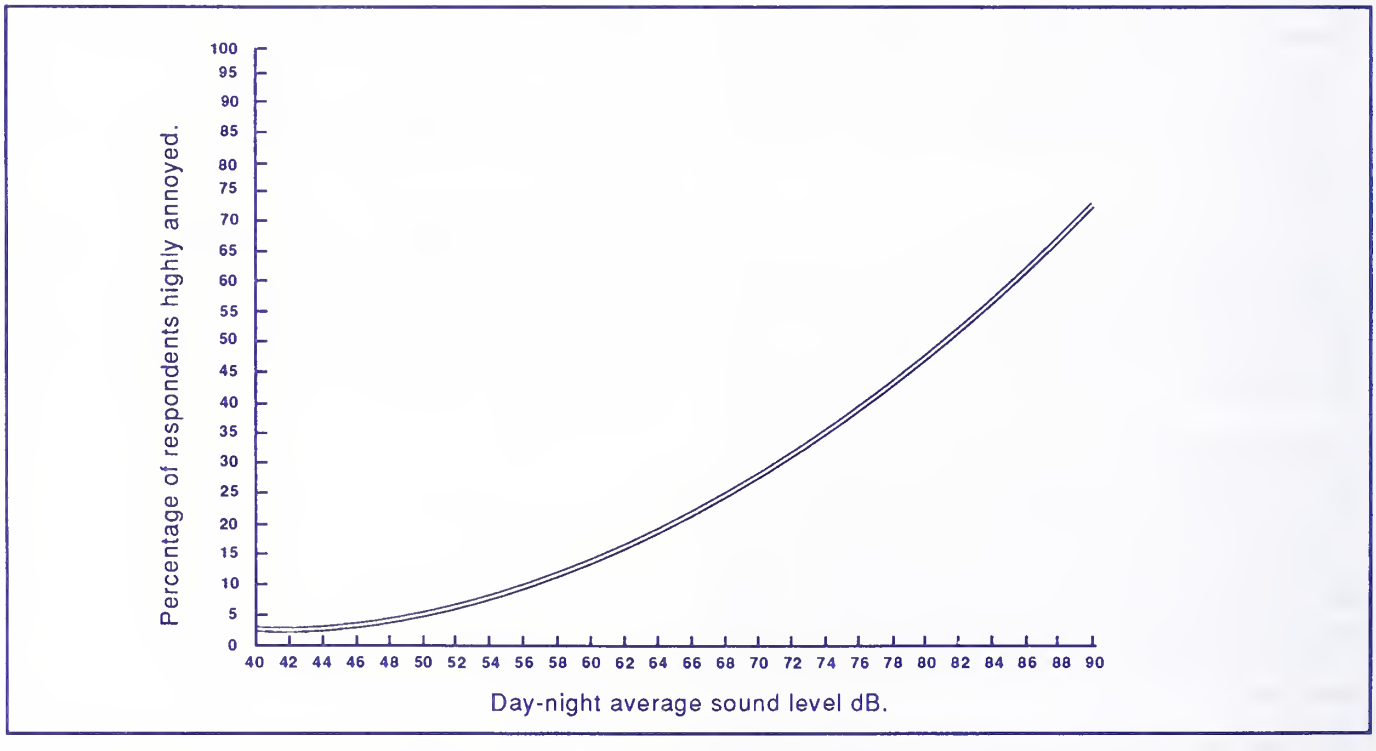


Figure 1.—Relationship between noise exposure and percentage of community highly annoyed. (Adapted from reference 1.)

obtain the background level, the result was an Leq of 51.8 dBA. This means that the total change to the overall A-weighted Leq for that 50-minute segment was 4.6 dB. Using the annoyance-percentage graph as a guideline, this results in an increase from about 7 percent annoyance with the background sound only, to about 10 percent when the helicopter sounds are included. This indicates that there is some level of annoyance associated with the background sounds alone. The addition of the sound from the helicopter operations, at that particular activity level, might result in a small increase in the number of people annoyed.

Sound sources that contributed to the overall background sound level included numerous fixed wing propeller driven aircraft, trucks and cars driving on the adjacent roads, and two jet aircraft takeoffs.

Site #2

Site #2 is located on the shore of Auke Bay, in a residential area approximately one mile south of Glacier Highway along Fritz Cove Road on the west side of the Mendenhall Peninsula. (See figure 2.) This site is approximately two miles west of Juneau Airport and helicopters can be seen and heard from the site as they fly their west flight routes.

At this site, measurements were taken in two 50-minute test segments on June 18, 1993. The first segment had two events in which helicopters could be heard. The second segment contained five events in which helicopters could be heard and therefore was chosen to be analyzed in order to obtain the "worst case" scenario.

The combined Leq (including both the background and helicopter sounds) for the 50-minute segment was 57.9 dBA. After removing the helicopter sounds to obtain the background level, the result was an Leq of 57.4 dBA. This means that the total change to the overall A-weighted Leq for that 50-minute segment was only 0.5 dB, which is so small it is not significant. Again, using the annoyance-percentage graph as a guideline, approximately 11 percent annoyance with the background sounds alone might be expected. The addition of the helicopter sounds, given the same level of activity, does not measurably change the Leq and therefore would not be expected to increase annoyance.

Helicopters were audible for a combined total of approximately 7 minutes out of the 50-minute test segment, which amounts to about 14 percent of the time. Other sound sources which contributed to the overall background level included two jet takeoffs, numerous fixed wing propeller driven aircraft, automobile traffic on the adjacent road, and the wake of a passing ship breaking on the shore of Auke Bay.

Site #3

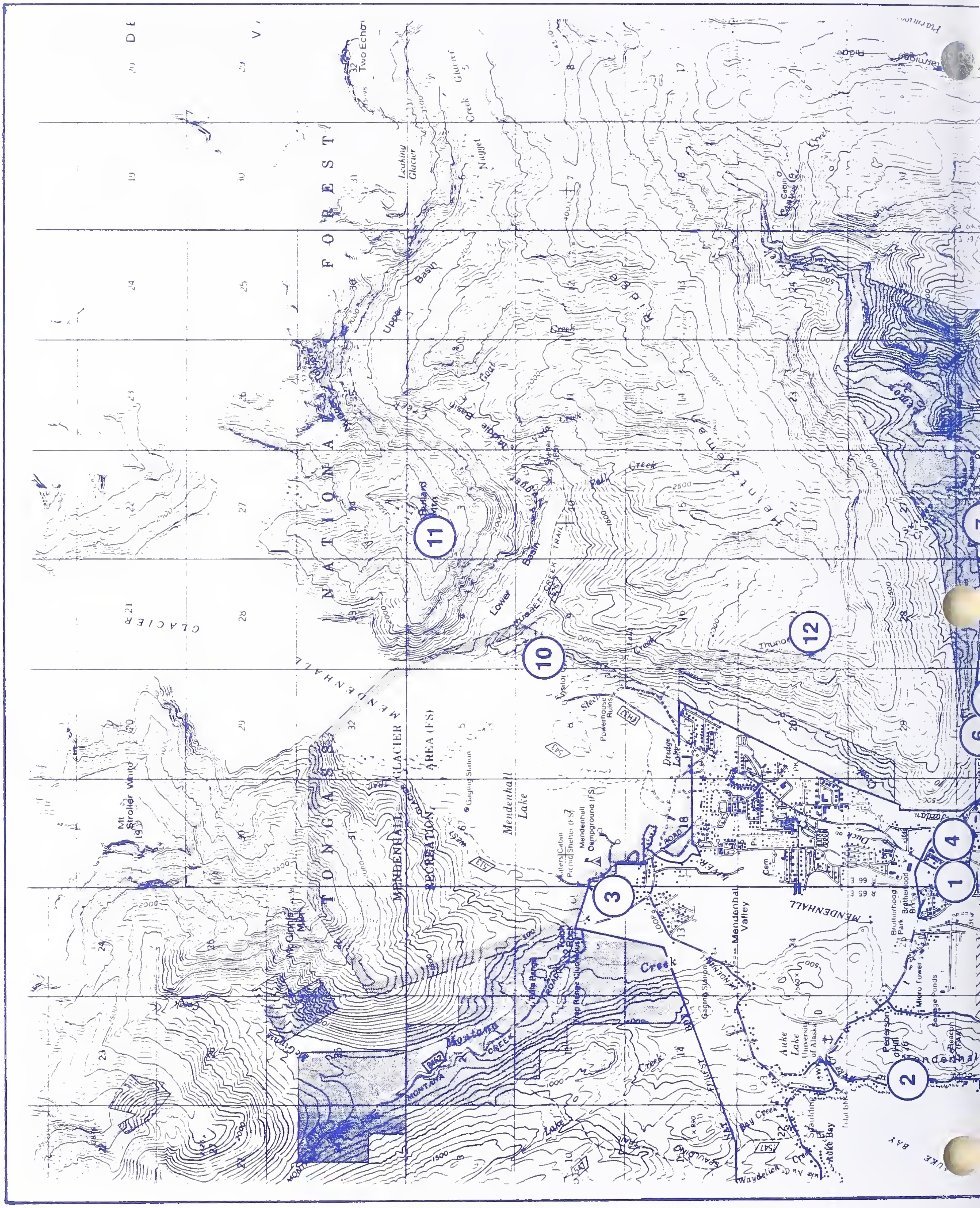
Site #3 is in a relatively quiet residential neighborhood near Mendenhall Lake and National Forest System Lands. (See figure 2.) It measures approximately 0.2 miles by 0.3 miles, and is located approximately four miles north of Juneau Airport. Temsco's and Coastal's west flight paths are near this area and helicopters can be seen and heard from this site when those routes are in use. At this site, the background sound level was relatively low and mainly consisted of distant fixed wing propeller and jet powered aircraft sound.

At this site, acoustic measurements were made on June 18, 1993, with staged helicopter approaches and departures to a nearby site for possible consideration as an alternative heliport.

General analysis of the data collected for the alternative heliport site suggests that the location is not appropriate. Because of the relatively low background sounds measured, the introduction of a heliport would likely result in more of an impact than the current heliport. Planning an alternative heliport, such as this, would require a much more extensive study.

A 50-minute test segment was recorded on June 20, 1993 to evaluate the impact from the currently used routes. The combined Leq (including both the background and helicopter sounds) for the 50-minute segment was 47.7 dBA. Sound from the helicopters was audible for a combined total of approximately 10 minutes during the 50-minute segment, which amounts to 20 percent of the time. After removing the helicopter sounds to obtain the background level, the result was an Leq of 39.3 dBA. This means that the total change to the overall A-weighted Leq for that 50-minute segment was 8.4 dB. Using the annoyance-percentage graph as a guideline, this results in an increase from about 2 percent annoyance with the background sound only, to 5 percent when the helicopter sounds are included. This indicates that during the measurement periods, the background sounds were at a low enough level that only very few people would be annoyed. The addition of the helicopter sounds might increase the number of people who would be annoyed, however the overall annoyance percentage would still be relatively low.

This was the highest change in the overall Leq of all the residential site measurements and is likely due to several factors. One of those is the fact that the background sound level at that location is relatively low. Another factor is that there are virtually no terrain features to provide barriers between the site and the helicopters when they are flying the west routes. This exposes the site to the helicopter sound for longer periods of time when compared to the other sites. Therefore, more sound energy is received.



TONGASS NATIONAL FOREST
MENDENHALL GLACIER RECREATION AREA (FS)
Mendenhall Lake
Mendenhall Valley
Upper Basin
Lower Basin
Leaking Glacier
Nugget
Powerhouse Ruins
Dredge Lake
Mt Stroller White
Two Echo
Gaging Station
Auke Lake
University of Alaska
Auke Bay
Brotherhood Park
Brotherhood Bridge
Pederson Hill
Micro Tower
Sewage Ponds
Montana Creek
MENDENHALL

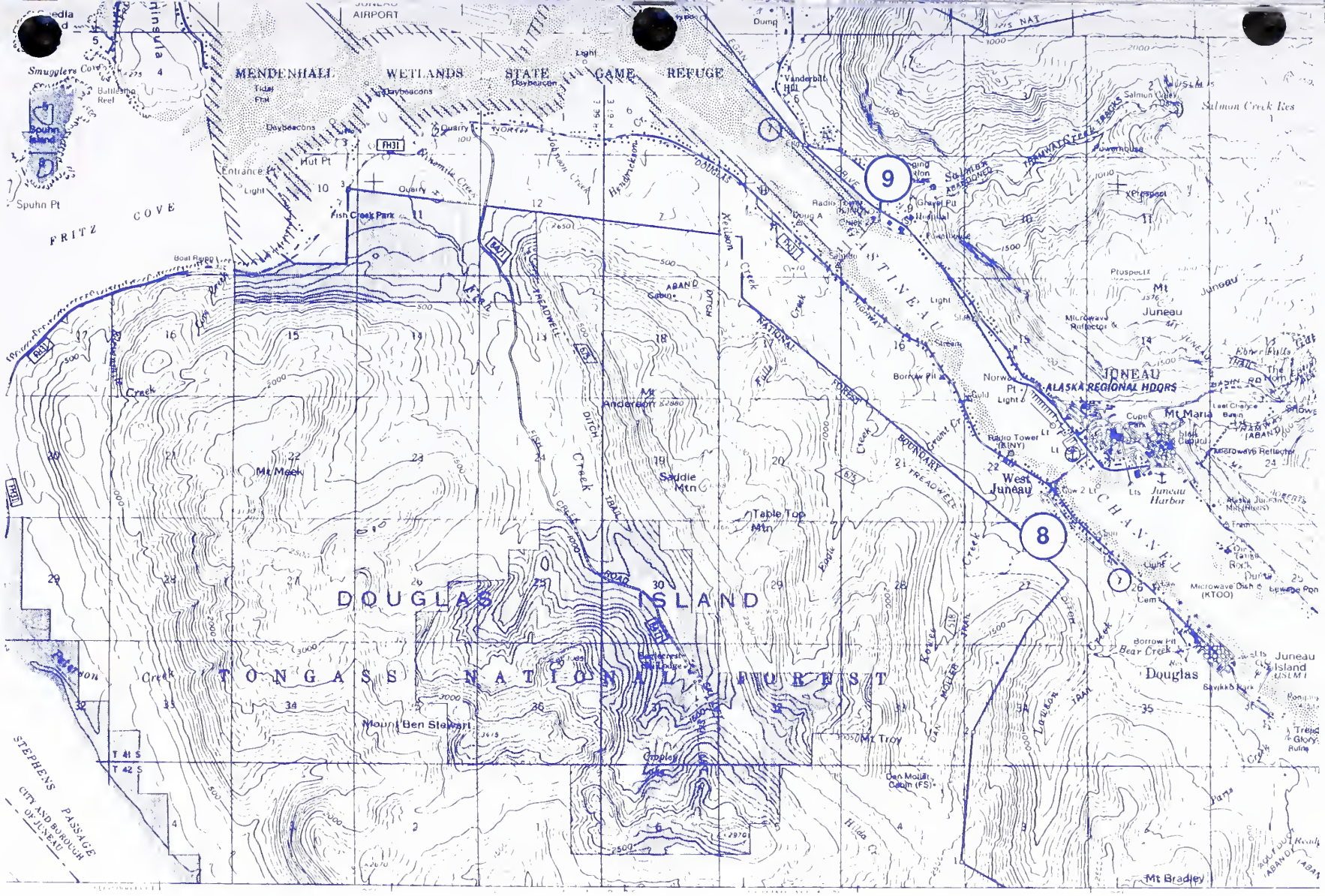


Figure 2.—Alaska Helicopter Tours Sound Measurements Site Locations - Juneau Area.

It must be noted that these measurements were taken when there was a 2000- to 3000-foot cloud ceiling obscuring the mountains and ridges along the other "fair weather" routes. This has two effects, one being the increased use of the west route by the helicopters, and the other being the virtual absence of fixed wing sightseeing traffic in the vicinity due to restrictions caused by the low ceilings. This concentrates the impact of the helicopter sound to areas along that route and does not allow much contribution to the background sound level by fixed wing traffic which might otherwise be operating in that area. Measurements were taken during these low ceiling conditions to attempt to get the worst case impact. Measurements there, during fair weather when the helicopters use other routes and fixed wing aircraft are active in the area, would obviously yield different results (less impact).

Site #4

Site #4 is located approximately 1/4 mile north of Juneau Airport, in the same general area as Site #1. This location is surrounded by Egan drive, Glacier Highway, and Mendenhall Loop Road. (See figure 2.) The site is located on the southern end of the subdivision and is closest to the airport.

At this site, one test segment was recorded on June 18, 1993. The combined Leq (including both the background and helicopter sounds) for the 49-minute segment was 55.3 dBA. The helicopters were audible for a combined total of approximately 5 minutes during the test, or 10 percent of the time. After removing the helicopter sounds to obtain the background level, the result was an Leq of 53.5 dBA. This means that the total change to the overall A-weighted Leq for that 49-minute segment was 1.8 dB. Using the annoyance-percentage graph as a guideline, this results in a slight increase from about 7 percent annoyance with the background sound only, to about 9 percent when the helicopter sounds are included. This indicates that some annoyance would be expected in that area even without the helicopter sounds. The presence of the helicopter sounds might only slightly increase the number of people annoyed.

The background sound during the 50-minute test segment consisted of numerous takeoffs by fixed wing propeller driven aircraft, one jet takeoff, and cars and trucks driving on the adjacent residential street.

Site #5

Site #5 is located in a residential area along Glacier Highway (which runs parallel to Egan Drive) approximately 1/2 mile northeast of Temsco's heliport location on the Juneau Airport. The site is at the southern base of Heinzleman Ridge. (See figure 2.)

Two 50-minute test segments were recorded on June 20, 1993 and one 50-minute segment was recorded on June 22, 1993. One segment from the June 20 tests was analyzed. The combined Leq (including both the background and helicopter sounds) for the 50-minute segment was 54.9 dBA. When combined, the total time during which the helicopters could be heard was approximately 4 minutes, which amounts to 8 percent of the total test segment time. After removing the helicopter sounds to obtain the background level, the result was an Leq of 54.3 dBA. This means that the total change to the overall A-weighted Leq for that 50 minute segment was 0.6 dB, so small that it is not significant. Again, using the annoyance-percentage graph as a guideline, approximately 8 percent annoyance with the background sounds alone might be expected. The addition of the helicopter sounds, given the same level of activity, does not measurably change the Leq and therefore would not tend to increase annoyance.

The background sound at this site consisted of almost constant sound from the adjacent roadways, sound from fixed wing jet and propeller driven aircraft, and some sound from neighbors' cars on the driveway directly adjacent to the test site.

Site #6

Site #6 is also along Glacier Highway, in the same general area as Site #5, but is approximately 0.15 miles closer to the Temsco Heliport area. (See figure 2.)

The background sound level was relatively high at this site and made it difficult to distinguish the helicopter sounds from the almost constant sound from road traffic on the adjacent road and highway.

A 52-minute test segment was recorded on June 21, 1993. The combined Leq (including both the background and helicopter sounds) for the 52-minute segment was 61.7 dBA. At this site, the helicopter sound was audible for about 9 minutes during the test segment, or about 17 percent of the time. After removing the helicopter sounds to obtain the background level, the result was an Leq of 61.3 dBA. This means that the total change to the overall A-weighted Leq for that 52-minute segment was 0.4 dB. Referring to the annoyance-percentage graph, approximately 15 percent annoyance with the background sounds alone might be expected. The addition of the helicopter sounds, given the same level of activity, does not measurably change the Leq and therefore would not tend to increase the amount of annoyance.

Site #7

Site #7 is located in Lemon Creek Valley, approximately three miles east of Juneau Airport between the Heinzleman and Blackerby Ridges, on the west side of a subdivision which measures approximately 1/2 mile by 1/3 mile, and borders a commercial and

industrial area to the south. (See figure 2.) Helicopters can be seen and heard from this site when they are flying the Heinzleman Ridge Route.

One test segment was recorded at this site on June 21, 1993. The combined Leq (including both the background and helicopter sounds) for the 50-minute segment was 50.3 dBA. Sound from the helicopters could be heard for approximately 11 minutes during the test segment at this site, which amounts to about 22 percent of the time.

After removing the helicopter sounds to obtain the background level, the result was an Leq of 47.3 dBA. This means that the total change to the overall A-weighted Leq for that 50-minute segment was 3.0 dB. The annoyance-percentage graph for this site suggests that a slight increase from just under 5 percent annoyance to about 6 percent annoyance might be expected with the introduction of the helicopter sounds.

The background sound at this site consisted of distant road traffic sound, fixed wing jet and propeller driven aircraft, a neighbor's barking dog, and local traffic on the adjacent residential street.

Site #8

Site #8 is located across the Gastineau Channel from downtown Juneau, in west Juneau, approximately seven miles southeast of Juneau Airport. The site is at the top of the Blueberry Hills subdivision, approximately 500 feet above sea level at the base of the mountains on Douglas Island. (See figure 2.) ERA helicopters fly directly over this site and float planes can be seen and heard operating out of Gastineau Channel.

One test segment was recorded at this site on June 22, 1993. The combined Leq (including both the background and helicopter sounds) for the one-hour and four-minute segment was 55.4 dBA. After removing the helicopter sounds to obtain the background level, the result was an Leq of 54.0 dBA. This means that the total change to the overall A-weighted Leq for that segment was 1.4 dB. From the annoyance-percentage graph, these levels indicate that about 8 percent annoyance might be expected from the background sounds alone, and a very slight increase to about 9 percent might be expected after the sound from the helicopters is added.

The helicopters were audible for a total of approximately five minutes of the one-hour and four-minute segment, or approximately 8 percent of the time. The background sound was dominated by the floatplane operations from Gastineau Channel, near downtown Juneau.

Site #9

Site #9 is located in a small residential area approximately five miles southeast of Juneau Airport, at the southwestern base of Blackerby Ridge, near Salmon Creek. (See figure 2.)

One test segment was recorded at this site on June 22, 1993. The combined Leq (including both the background and helicopter sounds) for the 58-minute segment was 54.0 dBA. The helicopters were audible for a combined total of approximately 11 minutes, or about 19 percent of the total test segment time. After removing the helicopter sounds to obtain the background level, the result was an Leq of 52.5 dBA. This means that the total change to the overall A-weighted Leq for that segment was 1.5 dB. This change in level corresponds to a change from about 7 percent annoyance to about 8 percent on the annoyance-percentage graph, meaning that very few additional people would tend to be annoyed with the slight increase in sound levels associated with the helicopter activities.

Background sound at this site consisted of road traffic sound from the nearby highway, fixed wing jet and propeller driven aircraft, and wind blowing through the trees. A small amount of sound could be heard from children playing and traffic on the adjacent residential streets.

Site #10

Site #10 is located approximately one mile north of the Mendenhall Glacier Visitor Center, on the east Glacier Trail, approximately 300 feet above sea level, and is about 5 miles north of Juneau Airport. (See figure 2.) Background sound at this site consisted of fixed wing aircraft sound, wind sound, and some sound from hikers on the trail.

One test segment was recorded at this site on June 22, 1993. The combined Leq (including both the background and helicopter sounds) for the 50-minute segment was 54.5 dBA. The helicopters were audible for a combined total of approximately 9 minutes, or about 18 percent of the time during the test segment. After removing the helicopter sounds to obtain the background level, the result was an Leq of 49.4 dBA. This means that the total change to the overall A-weighted Leq for that 50-minute segment was 5.1 dB. Using the annoyance-percentage graph as a guideline, this results in an increase from about 6 percent annoyance with the background sound only, to about 9 percent when the helicopter sounds are included. This indicates that there is likely some level of annoyance associated with the background sounds alone, and the addition of the sound from the helicopter operations, at that particular activity level, might result in a 3 percent increase in the number of people annoyed.

Site #11

Site #11 is located approximately 4200 feet above sea level, six miles north of Juneau Airport, on Bullard

Mountain. (See figure 2.) Measurements were taken here to analyze any possible impact to a herd of mountain goats residing on the mountain. Helicopters and fixed wing airplanes can be seen and heard from the site as they fly to and from the Juneau Icefields below.

The 53-minute segment recorded on June 23, 1993 was analyzed, and the combined Leq (including both the background and helicopter sounds) for the entire segment was 46.4 dBA. Sound from helicopters could be heard for a total of approximately 16 minutes during the test segment, which amounts to about 30 percent of the time. After removing the helicopter sounds to obtain the background level, the result was an Leq of 37.2 dBA. This results in a change of 9.2 dB.

The background sound level at this site was low and consisted of sound from a distant waterfall, distant road traffic in the valley below, and fixed wing aircraft sound.

A recent study on the effects of aircraft overflights and the associated sound on wildlife concludes that most animals habituate readily to the presence of sound. (Reference 3.) The overall levels measured in this study are relatively low and would not pose a threat to the safety of the animals' hearing mechanisms.

Site #12

Site #12 is located at the top of Heinzleman Ridge, at approximately 2800 feet above sea level, and three miles northwest of Juneau Airport. (See figure 2.) Helicopters fly almost directly over this site when using the Heinzleman Ridge Route.

A high level of wind noise at this site prevented a meaningful analysis, and therefore, results from this site are not included in this report.

CONCLUSIONS

The sound levels from the helicopters in this study were not high enough, nor of long enough duration, to pose a threat to hearing safety for either humans or animals. (References 3 and 4.) Therefore, the only possible acoustic impact resulting from the helicopter sounds is that of annoyance to people who reside in areas close to the helicopter flight paths.

The overall impact, as gauged by an increase on the annoyance-percentage graph due to the helicopter sounds, is low for most of the measurement sites during this study. Even the sites with a larger difference between the background and combined levels still had overall sound levels that rated relatively low on the annoyance-percentage relationship graph. (Reference 1.)

Other sound sources such as fixed wing propeller and jet aircraft, road traffic, and other man-made sounds are prevalent at most of the measurement sites. Higher background sound levels from these other sources tend to mask the helicopter sounds, to some extent. Therefore, areas with these higher background sound levels will tend to be less impacted by the helicopter sounds.

Attitude is a major factor in human response to sound with respect to annoyance. (Reference 1.) Some listeners will not be satisfied until no sounds from helicopters can ever be detected. (Reference 6.)

Use of "Fly Neighborly" techniques by the tour operators will keep impacts to a minimum, and the use of newer helicopters designed specifically for quiet operation will likely allow an increase in use without an increase in impact (Reference 5.)

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